

Claims

What is claimed is:

1. Hydraulic transmission system comprising:

a supply means adapted to supply hydraulic working fluid at variable pressure to at least two working lines;

at least two hydraulic users connected to said supply means via said at least two working lines in a closed circuit configuration;

a control adapted to generate a control signal indicative of a desired flow rate of the hydraulic working fluid supplied by said supply means; and

a second connection control responsive to said control signal and adapted to control the connection of working line portions connected to the at least two users so as to selectively provide serial and parallel connection of the at least two hydraulic users in response to said control signal.

2. The hydraulic system, as set forth in claim 1, wherein said control is a hydraulic control adapted to generate a hydraulic control fluid with varied pressure as said control signal.

3. The hydraulic system, as set forth in claim 2, wherein:

said supply means includes a hydraulic adjustment device for adjusting the variable pressure of the hydraulic working fluid;

said hydraulic control has an actuated condition in which the hydraulic control generates said hydraulic control fluid having a control pressure which is adjustable between a first control pressure and a second control pressure; and

said hydraulic system further includes a first connection control operable by said hydraulic control fluid supplied from said hydraulic control and adapted to direct, upon actuation of said hydraulic control, said hydraulic control fluid to said hydraulic adjustment device.

4. The hydraulic system, as set forth in claim 2, wherein said hydraulic control generates a continuously variable control signal between a first control signal value and a control signal value; and wherein said second connection control is adapted to control the connection of the working line portions so as to change substantially smoothly from a serial connection configuration at the first control signal value to a parallel connection configuration at the second control signal value.

5. The hydraulic system, as set forth in claim 4, wherein said second connection control includes a directional valve having a first extreme position in which it connects the working line portions in a serial connection configuration of the at least two users and having a second extreme position in which it connects the working line portion in a parallel connection configuration of the at least two users, said directional valve being adapted to change its position responsive to the control signal.

6. The hydraulic system, as set forth in claim 5, wherein said directional valve is proportional and changes its position from the first extreme position to the second extreme position responsive and proportional to said control signal.

7. The hydraulic system, as set forth in claim 6, wherein said directional valve is a 6-way proportional valve adapted to depressurize the working line portions connected in a serial connection configuration when changing its position from the first extreme position to the second extreme position.

8. The hydraulic system, as set forth in claims 7, wherein said directional valve is pilot operated by said hydraulic control fluid supplied by said hydraulic control.

9. The hydraulic system, as set forth in claim 8, wherein said directional valve has a second pilot line selectively connectable to the hydraulic control fluid of the hydraulic control, said directional valve being movable from the first extreme position towards the second extreme position dependent on said varied pressure of said hydraulic control fluid.

10. The hydraulic system, as set forth in claim 9, wherein said hydraulic control has at least first and second control outputs supplying hydraulic control fluid and associated with respective first and second modes; said first and second control outputs being selectively connectable to said second pilot line of said directional valve.

11. The hydraulic system, as set forth in claim 10, wherein said hydraulic system further includes a second switching device adapted to connect the second pilot line of the directional valve to a selected one of the first or second control outputs of the hydraulic control.

12. The hydraulic system, as set forth in claim 11, wherein said second switching device includes first and second check valves having their respective inputs connected to the first and second control outputs of the hydraulic control and having their respective outputs connected to the second pilot line of the directional valve.

13. The hydraulic system, as set forth in claim 3, wherein said first connection control includes a distributor connected to said hydraulic adjustment device, said distributor having a control position in which it directs said hydraulic control fluid to said hydraulic adjustment device upon actuation of said hydraulic control, said distributor further having a neutral position in which it connects the hydraulic adjustment device to a hydraulic fluid tank.

14. The hydraulic system, as set forth in claim 13, wherein said distributor includes a pilot operated directional distributor valve having a distributor pilot line connected to said hydraulic control fluid from the hydraulic control and being movable into said control position upon supply of said hydraulic control fluid on said distributor pilot line so as to selectively direct said hydraulic control fluid from the hydraulic control to said hydraulic adjustment device.

15. The hydraulic system, as set forth in claim 14, wherein said first and second control outputs of said hydraulic control are connected to first and second distributor pilot lines of the directional distributor valve to move the distributor valve in an associated first or second control position, said hydraulic adjustment device being responsive to the first or second control position so as to cause said supply means to supply said hydraulic working fluid in a selected one of first and second flow directions in the hydraulic system, said first and second flow directions being associated with said first and second control positions.

16. The hydraulic system, as set forth in claim 13, wherein said first connection control includes a first switching device adapted to connect a supply line of said distributor to the hydraulic control fluid from the hydraulic control in response to actuation of the hydraulic control.

17. The hydraulic system, as set forth in claim 16, wherein said first switching device is adapted to connect said hydraulic adjustment device to a supply of hydraulic fluid having constant pressure in the non activated condition of the hydraulic control and to disconnect said supply of hydraulic fluid having constant pressure from the hydraulic adjustment device in the activated condition of the hydraulic control.

18. The hydraulic system, as set forth in claim 17, wherein said first switching device is a pilot operated directional on-off valve having an activated position in which the directional on-off valve directs said hydraulic control fluid from said hydraulic control to the distributor.

19. The hydraulic system, as set forth in claim 18, wherein said directional on-off valve further has a neutral position in which it connects said hydraulic adjustment device to said supply of hydraulic fluid having constant pressure.

20. The hydraulic system, as set forth in claim 19, wherein said directional on-off valve has a first pilot line selectively connectable to the hydraulic control fluid of the hydraulic control, said directional on-off valve being movable to its activated position upon receiving hydraulic control fluid on said first pilot line.

21. The hydraulic system, as set forth in claim 20, wherein said second switching device of said hydraulic system selectively connects the first pilot line of the directional on-off valve to the first or second control outputs of the hydraulic control.

22. The hydraulic system, as set forth in claim 21, wherein said second switching device includes first and second check valves having their

respective inputs connected to the first and second control outputs of the hydraulic control and having their respective outputs connected to the first pilot line of the directional on-off valve.

23. The hydraulic system, as set forth in claim 22, wherein said second switching device selectively directs hydraulic control fluid of one of the first and second outputs of the hydraulic control to a control fluid input of the directional on-off valve, said control fluid input being connected to a control fluid output of the directional on-off valve in its activated position.

24. The hydraulic system, as set forth in claim 14, wherein said supply means includes a variable displacement pump of the axial piston type with swash plate design and said hydraulic adjustment device includes a double acting servo piston connected to said variable displacement pump.

25. The hydraulic system as set forth in claim 24, wherein, in said control position, said directional distributor valve directs said hydraulic control fluid from the hydraulic control to an associated one of the piston chambers of the servo piston.

26. The hydraulic system, as set forth in claim 25, wherein said directional distributor valve has a neutral position in which no hydraulic control fluid is supplied to the pilot line, and wherein said neutral position of said directional distributor valve connects both chambers of the servo piston to a tank to balance the position of said servo piston.

27. A method of controlling a hydraulic transmission system, said transmission system having a supply means adapted to supply hydraulic working fluid at variable flow rate to at least two working lines, and at least two

hydraulic users connected to said supply means via said at least two working lines in a closed circuit configuration; said method comprising the steps of:

providing a control signal indicative of a desired flow rate of the hydraulic working fluid supplied by said supply means;

controlling the connection of working line portions connected to the at least two users so as to selectively provide serial and parallel connection of the at least two hydraulic users in response to said control signal.

28. The method, as set forth in claim 27, wherein said control signal is provided continuously variable between a first control signal value and a second control signal value; and

wherein said connection of the working line portions is controlled so as to change substantially smoothly from a serial connection configuration at the first control signal value to a parallel connection configuration at the second control signal value.

29. The method, as set forth in claim 28, wherein said connection of the working line portions is controlled by a second connection control operated by said control signal.

30. The method, as set forth in claim 29, wherein said second connection control is operable by a hydraulic pilot pressure, and wherein said control signal is provided in the form of hydraulic control fluid having variable pressure corresponding to the desired pressure of the working fluid, said method further including the step of pilot operating said second connection control by said hydraulic control fluid.

31. The method, as set forth in claim 27, wherein said supply means includes an hydraulic adjustment device for adjusting the variable flow rate of the hydraulic working fluid; said method further including the steps of:

providing a hydraulic control fluid having a control pressure which is adjustable between a first control pressure and a second control pressure, said control pressure being indicative of a desired flow rate of the hydraulic working fluid;

selectively directing said hydraulic control fluid during an actuated condition to said hydraulic adjustment device, and

operating said hydraulic adjustment device by means of said hydraulic control fluid.

32. The method, as set forth in claim 31 wherein said actuated condition during which said hydraulic control fluid is selectively directed to said hydraulic adjustment device corresponds to providing said hydraulic control fluid with said first pressure.

33. The method, as set forth in claim 32, including, in a non-actuated condition, providing hydraulic fluid at constant pressure to said hydraulic adjustment device and connecting the same to a tank of hydraulic fluid.

34. The method, as set forth in claim 33, wherein said hydraulic transmission system includes a first connection control adapted to selectively direct said hydraulic control fluid to said hydraulic adjustment device, said method including the step of operating said first connection control by said hydraulic control fluid.